

Towards urban resilience through sustainable drainage systems: a multi-objective optimisation problem

Article

Supplemental Material

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This section provides a summary of the key hydrological and hydraulics information used to build the analytical model in this study.

Table 3 – General information

Method	Horton
Build-up, Wash-off methods	Exponential
Min infiltration rate (mm/hr)	5
Max infiltration rate (mm/hr)	115
Decay (1/hr)	6
Evaporation: a time series (mm/day)	53.41

Table 4 – Build-up and wash-off parameters in the Mineirinho catchment

Land-use	Build-up									Wash-off								
	Max. buildup (kg/ha)			Rate constant			Coefficient			Exponent			Cleaning efficiency %			BMP efficiency %		
	TSS	TP	TN	TSS	P	TN	TSS	P	TN	TSS	P	TN	TSS	P	TN	TSS	P	TN
AGR*	337.96	0.00230	0.30	0.30	0.011	0.12	12.58	3.16	26.880	2.98	0.80	3.78	50	50	50	20	20	20
CGA*	37.54	0.00013	0.30	2.09	0.036	0.47	7.68	4.78	7.940	7.78	4.77	7.18	50	50	50	20	20	20
COM*	380.72	0.04900	0.26	0.32	0.011	0.23	11.24	0.77	25.690	4.54	0.51	5.32	50	50	50	20	20	20
FRS*	14.39	0.00011	0.22	0.58	0.018	0.19	3.54	2.37	4.250	5.37	1.38	5.40	50	50	50	20	20	20
IND*	448.91	0.05800	0.36	0.59	0.019	0.56	15.18	1.01	54.210	6.28	0.67	8.89	50	50	50	20	20	20
OPS*	214.87	0.00650	0.19	0.35	0.031	0.18	7.92	2.98	28.295	1.73	1.00	2.70	50	50	50	20	20	20
PNS*	18.77	0.00007	0.15	1.05	0.018	0.24	3.84	2.39	3.970	3.89	2.39	3.59	50	50	50	20	20	20
RDS*	117.29	0.00300	0.03	1.55	0.120	0.51	5.46	4.73	37.010	5.52	2.92	5.51	50	50	50	20	20	20
RGA*	37.54	0.00013	0.30	2.09	0.036	0.47	7.68	4.78	7.940	7.78	4.77	7.18	50	50	50	20	20	20
RSD*	18.00	0.03100	0.36	0.30	0.200	0.60	9.59	2.00	13.240	5.49	4.16	3.59	50	50	50	20	20	20

*AGR: Agriculture; CGA: Commercial Grass area; COM: Commercial; FRS: Forest; IND: Industrial; OPS: Open Space; PNS: Pines; RDS: Roads; RGA: Residential Grass area; RSD: Residential

Table 5 – GNR design parameters

Surface	Soil	Drainage mat/layer
Berm height (mm)	30	Thickness (mm)
Vegetation volume fraction	0.1	Porosity (volume fraction)
Surface roughness (Manning's n)	0.1	Field Capacity (volume fraction)
Surface slope (%)	1	Wilting point (volume fraction)
		Seepage rate (mm/hr)
		Conductivity slope
		Suction head (mm)

¹ Journal of Environmental Management, Vol 275, 1 December 2020, 111173 - <https://doi.org/10.1016/j.jenvman.2020.111173>

Table 6 – RNB design parameters

Storage depth (mm)	1000
Flow efficiency (mm/hr)	1
Flow exponent	0.5
Offset height (mm)	6
Drain delay (hr)	6

Table 7 – GSW design parameters

Berm height (mm)	600
Width (top, bottom) (m)	(3.0,1.0)
Vegetation volume fraction	0.3
Surface roughness (Manning's n)	0.368
Channel slope* (%)	7
Swale side slope (run/rise)	1:1

* the average slope of sub-catchments within the Mineirinho Catchment

Table 8 – PVP design parameters

Surface	Soil	Pavement	Storage	Drain
Berm height (mm)	200	Thickness (mm)	50	Thickness (mm)
			0	150
Vegetation volume fraction	0.1	Porosity (volume fraction)	0.5	Void ratio (voids/solids)
				0.15
Surface roughness (Manning's n)	0.1	Field capacity (volume fraction)	0.2	Void ratio (voids/solids)
				0.74
Surface slope (%)	7	Wilting point (volume fraction)	0.1	Seepage rate (mm/hr)
				0.5
		Permeability (mm/hr)	100	Offset height (mm)
				6
		Clogging factor	0	
		Seepage rate (mm/hr)	0.5	
		Conductivity slope	10	
		Suction head (mm)	3.5	

Table 9 – BIR design parameters in the Mineirinho catchment

Surface	Soil	Storage	Drain
Berm height (mm)	300	Thickness (mm)	500
Vegetation volume fraction	0.1	Porosity (volume fraction)	0.5
Surface roughness (Manning's n)	0.1	Field capacity (volume fraction)	0.2
Surface slope (%)	5	Wilting point (volume fraction)	0.1
		Seepage rate (mm/hr)	0.5
		Thickness (mm)	2700
		Void ratio (voids/solids)	0.75
		Seepage rate (mm/hr)	0.5
		Clogging factor	0
		Flow efficiency (mm/hr)	0
		Flow exponent	0.5
		Offset height (mm)	6

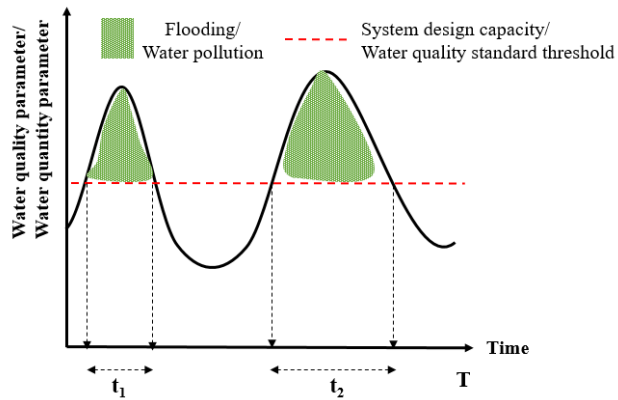


Fig. 1. Hypothetical flood resilience curve represents the excessive water beyond the design capacity of the drainage network over time; hypothetical water quality resilience curve demonstrates the violation of water quality from the defined water quality standards over time

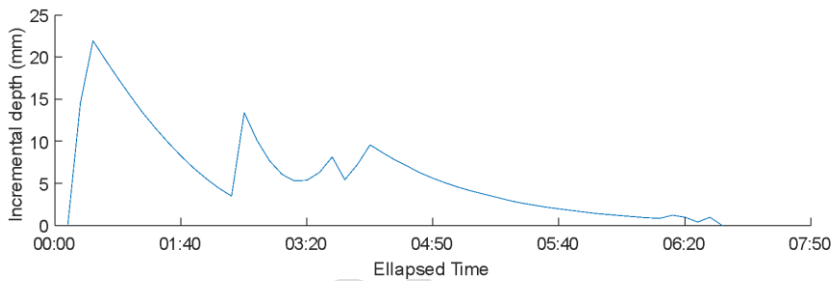


Fig. 2. The two-stage design storm rainfall pattern using Huff Heavy Storm equations